

## OPERATION AND APPLICATIONS

The Experimenter not only supplies the common DC voltages used in digital electronics, but it also supplies: a line frequency square wave (60 or 50 Hz); complementary clock signals of 1 Hz, 1 kHz and 100 kHz; logic and data switches to control input levels; and logic indicators to visually monitor logic states and transitions.

Figure 1 gives a brief description of each control function.

### CONNECTOR BLOCK

The connector blocks are designed to accept up to #20 (.032") solid wire and most common-component leads. The four connectors in a small connector block are internally connected together. Also, each vertical row of five connectors in the breadboarding socket are connected together as shown in the Figure. Thus, you can build simple or complex circuits without making solder connections.

Page 36 shows an example of a typical experiment. The breadboarding socket is designed to accommodate integrated circuits and the IC puller supplied in your kit fits down into the center channel of the breadboarding socket to gently and easily lift the IC out.

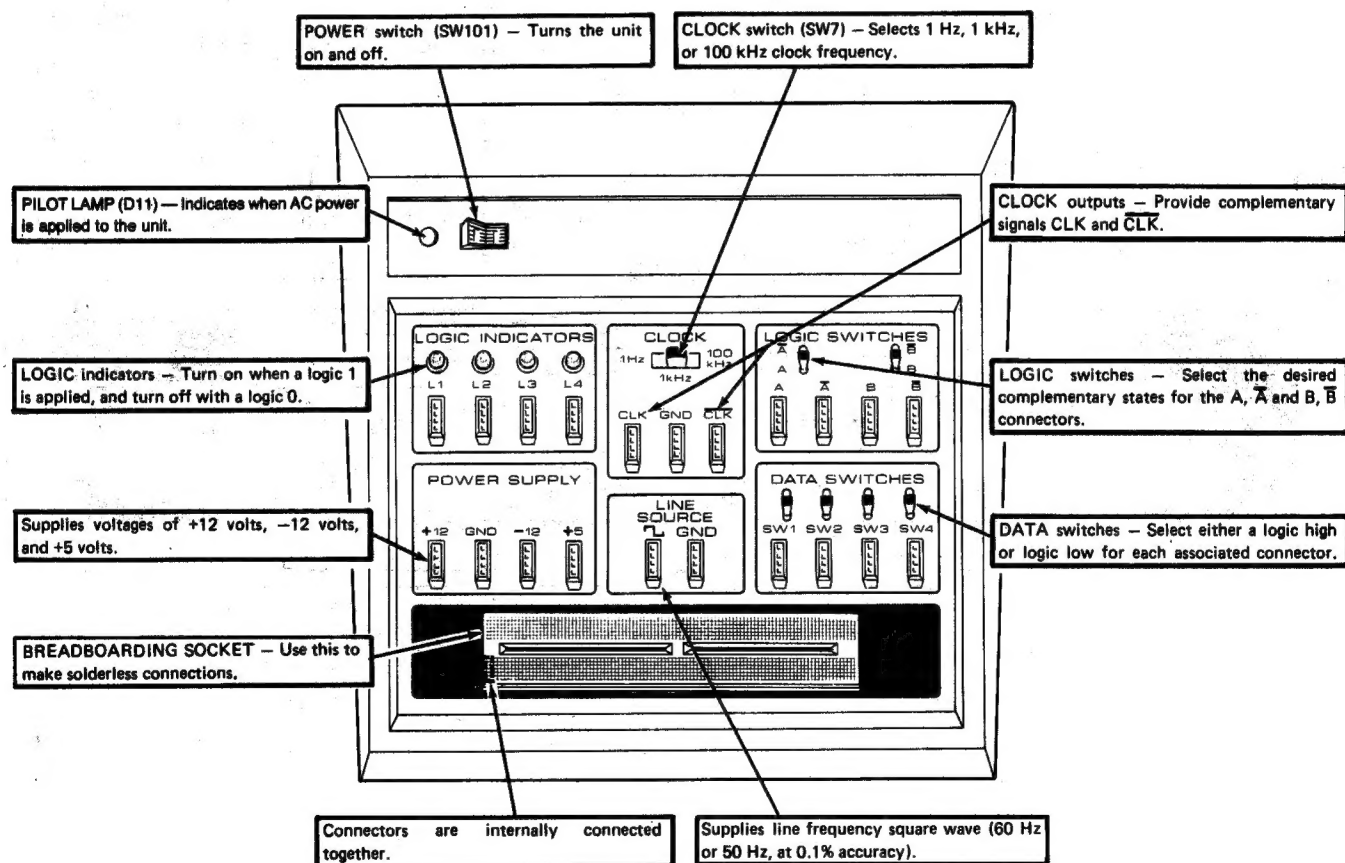


Figure 1

## SPECIFICATIONS

### Power Supplies:

Output Voltages .....	+12 volts DC at 100 mA. -12 volts DC at 100 mA. +5 volts DC at 500 mA with thermal overload protection.
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Load Regulation .....	+12 volts DC, better than 1%. -12 volts DC, better than 1%. +5 volts DC, better than 2%.
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### Data Switches:

States .....	+5 volts or 0 volts.
Maximum Current .....	10 mA, each switch.
Output .....	4 terminals, one for each switch.

### Logic Switches:

Type .....	Momentary contact, spring loaded.
Circuit .....	Two flip-flop latches for contact bounce buffering.
Output States .....	Complementary, +5 volts and +0.2 volts.

### Clock:

Frequency Selection .....	3-position slide switch.
Output Frequency .....	1 Hz, 1 kHz, 100 kHz; $\pm 20\%$ .
Duty Cycle .....	45%.
Output Voltage .....	5 volts peak-to-peak.
Output Terminals .....	Normal and complement.

Logic Indicators .....	Red light emitting diode (LED).
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### General:

Power Requirements .....	105-130 volts or 210-260 volts rms, 50-60 Hz, 15 watts maximum.
Fuse .....	3/16-ampere, slow-blow.
Dimensions .....	12-1/8" wide $\times$ 11-3/4" deep $\times$ 3-1/2" high.
Net Weight .....	4 lbs.

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The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

## CIRCUIT DESCRIPTION

Refer to the Schematic Diagram (Illustration Booklet Page 6) while you read this "Circuit Description."

### DATA SWITCHES

These switches select either ground potential or +5 volts DC. Resistor R39 limits the current.

### LOGIC SWITCHES

Switch  $A-\overline{A}$  controls a latching flip-flop made up of sections A and B of IC2. When switch SW5 is in the  $\overline{A}$  position, pins 1 and 2 are low. This produces a high at pins 3 and 4. Because pin 5 is floating at this time, it is also considered to be high. This makes a low at pin 6. When SW5 is in the A position, a low is at pin 5. This forces pins 6 and 2 high. With highs at pins 1 and 2, pins 3 and 4 go low and the outputs  $\overline{A}$  and  $\overline{A}$  have changed state.

Switch  $B-\overline{B}$  operates the same as switch  $A-\overline{A}$ .

### LOGIC INDICATORS

With no input to connector L1, transistors Q9 and Q10, and LED L1 are off. When a high is applied to connector L1, transistor Q9 turns on transistor Q10. Current then flows through LED L1, resistor R23, transistor Q10, and the LED turns on. The other indicators operate in the same manner.

### CLOCK

The clock is made up of IC3 (a 555 timer), and the RC time frequency control components. These are R46, R47, and C9, C10, or C11. Switch SW7 selects the desired capacitor. The output of IC3 (pin 3) is applied to two NAND gates that operate as inverters to produce the CLK and  $\overline{CLK}$  outputs.

### LINE FREQUENCY SIGNAL

The line frequency signal is coupled from the secondary of T101, through resistor R41, to the base of transistor Q17. Diode D9 half-wave rectifies the signal. This leaves the positive excursions to turn on transistor Q17. Transistor Q17 then drives section B of IC4, which is a NAND gate connected as an inverter.

### +5-VOLT SUPPLY

The secondary voltage of transformer T101 is rectified by diodes D1 through D4, filtered by capacitor C2, and regulated by IC1.

### 12-VOLT SUPPLIES

The center-tapped secondary of transformer T101 is rectified by diodes D5 through D8 and filtered by capacitors C1 and C6.

Transistor Q1 is a current amplifier for pass transistor Q2. If the current through Q2 becomes excessive, the voltage developed across R4 turns on transistor Q4. The current that was flowing through R2, R3, and Q1 now has another path, through Q4. Therefore, if Q4 turns on harder, less current flows into the base of Q1 and Q2. This in turn allows less current to flow from the collector to emitter of Q2 and the current is limited to a safe value.

If the output voltage changes, this change is sensed by voltage divider R6 and R7, and is applied to the base of Q3. The base voltage of Q3 therefore changes, but the emitter is held constant by ZD1. This causes the current through Q3 to change and again control Q1 and Q2 as before until the output voltage is at the proper value.

The positive 12-volt supply is used as the reference for the negative 12-volt supply. Voltage divider R17 and R18 monitor the outputs of the supplies and control Q7. The negative supply operates similar to the positive supply.

## IC Logic Compatibility

As shown in the following "IC Compatibility Chart," the power supplies and other circuitry of your Digital Experimenter are compatible with most of today's commonly used logic families. Figure 2 (on Page 39) shows how the power supply can be adapted for still another logic family, and Figures 3 and 4 show simple interface (connecting) circuitry between some of these families.

**IC COMPATIBILITY CHART**

TYPE OF IC	TYPICAL SUPPLY VOLTAGE	COMPATIBLE WITH INDICATOR AND SWITCHES	COMMENTS
RTL	+3.6V (See Note 1 on Page 39)	Yes (See Note 2 on Page 39)	
DTL	+5V	Yes	
TTL	+5V	Yes	Applies to open collector, Schottky, and 3-state types also.
CMOS	+5 +12V	Yes (when used with +5V supply)	Recommend +5VDC for indicator and switch compatibility.
ECL	+5.2V (See Note 3 on Page 39)	No (See Note 4 on Page 39)	Check ECL manufacturer's literature before using.
nMOS	+5V	Yes	Not all nMOS uses a +5 volt supply. Check manufacturer's data.
pMOS (See Note 5)	+5V -12V	Yes	TTL compatible, static types only.
Linear	+12V -12V	Not Applicable.	Good for op amps, line drivers and receivers, and other linear circuits.

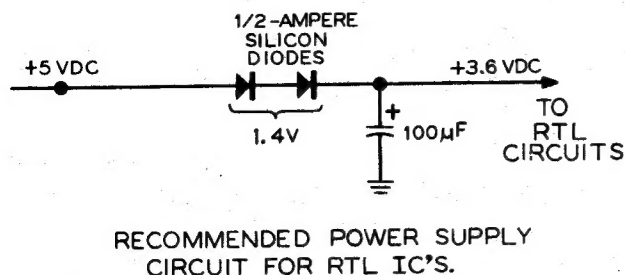


Figure 2

## NOTES:

1. Use circuit shown in Figure 2 to derive the recommended supply voltage for RTL IC's.
  2. Outputs of data and logic switches in the binary 1 state are a higher voltage than that required by RTL circuits. But the higher voltage will not damage RTL circuits and they will operate satisfactorily.
  3. The recommended ECL supply voltage is  $-5.2$  VDC. However, by reversing the ground and supply voltage connections,  $+5$  volts from the ET-3200 can be used. Connect the IC ground to  $+5$  volts and the normal supply input (VEE) to ground. This will produce satisfactory operation for most applications.
  4. Even with a  $+5$ -volt supply on the ECL circuits, this type of IC is not compatible with the switches and indicators on the ET-3200. With some simple circuit additions, you can obtain full compatibility. Figure 3 shows two simple circuits to convert standard TTL levels to ECL levels. The second circuit in Figure 3 can also be used to convert the clock, data switch, and logic switch outputs of the ET-3200 to ECL levels.
- Figure 4 shows circuits for converting ECL levels to TTL levels. All of these level translator circuits assume that both ECL and TTL circuits will be operating from the same  $+5$ -volts supply.
5. Static type only. Dynamic pMOS requires more sophisticated interfacing. In all cases, check the manufacturer's data sheets.

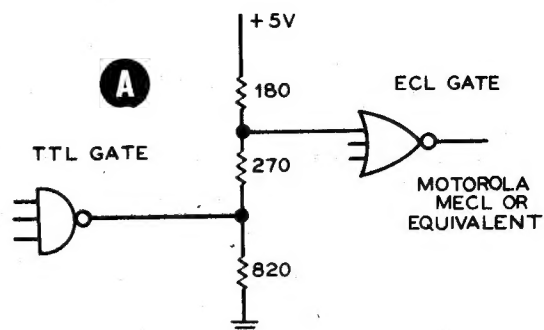
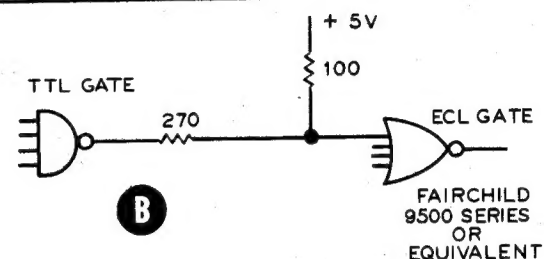
TTL TO ECL  
LEVEL TRANSLATORS

Figure 3

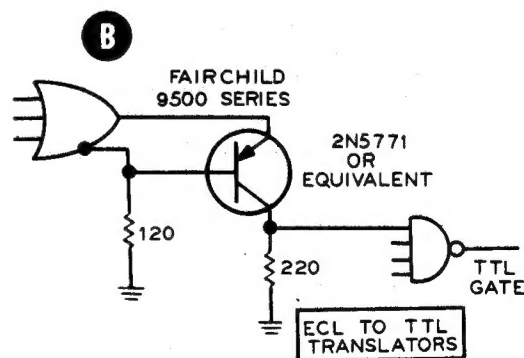
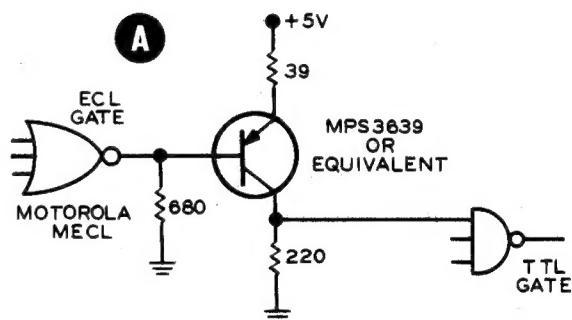
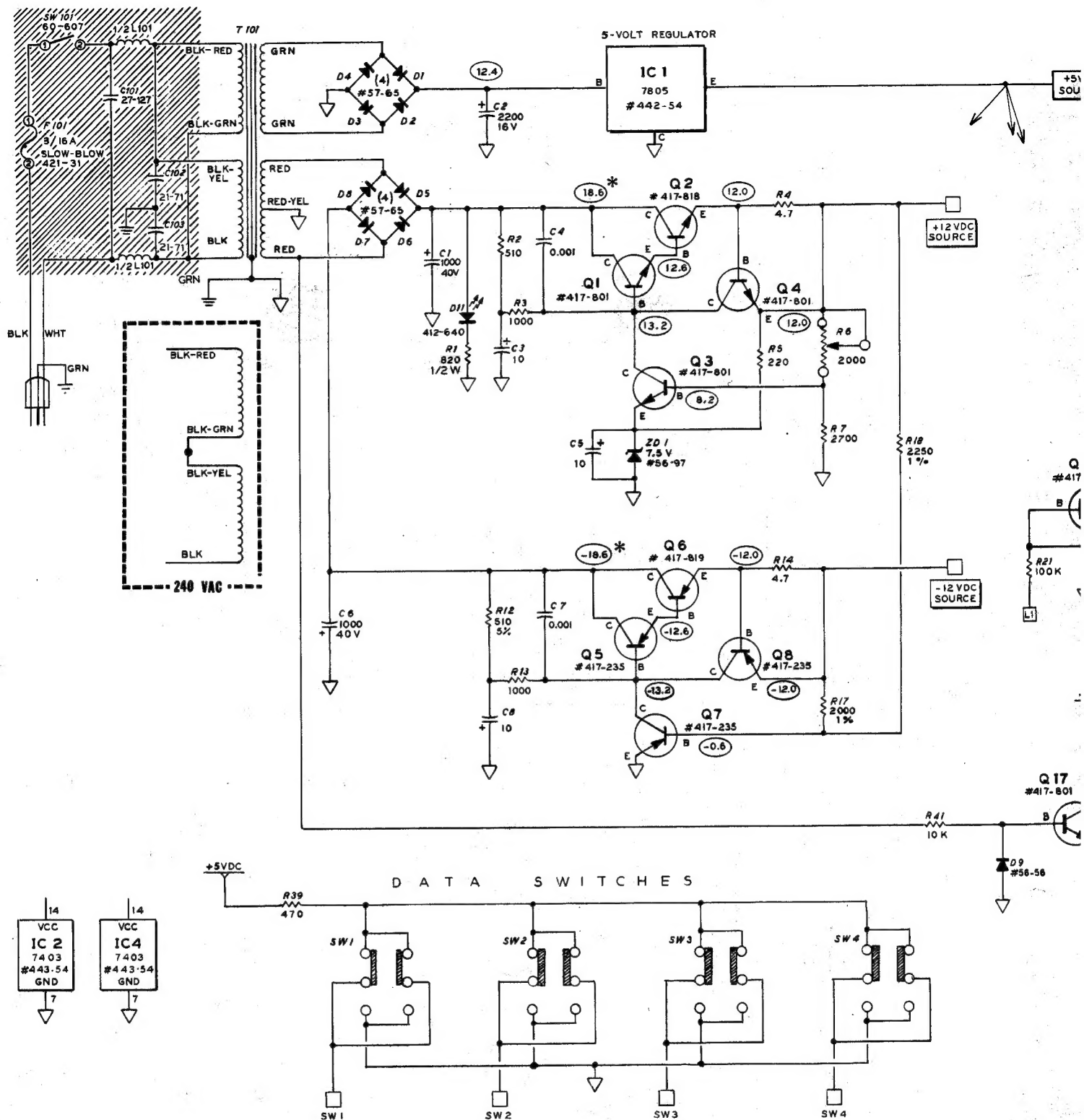


Figure 4

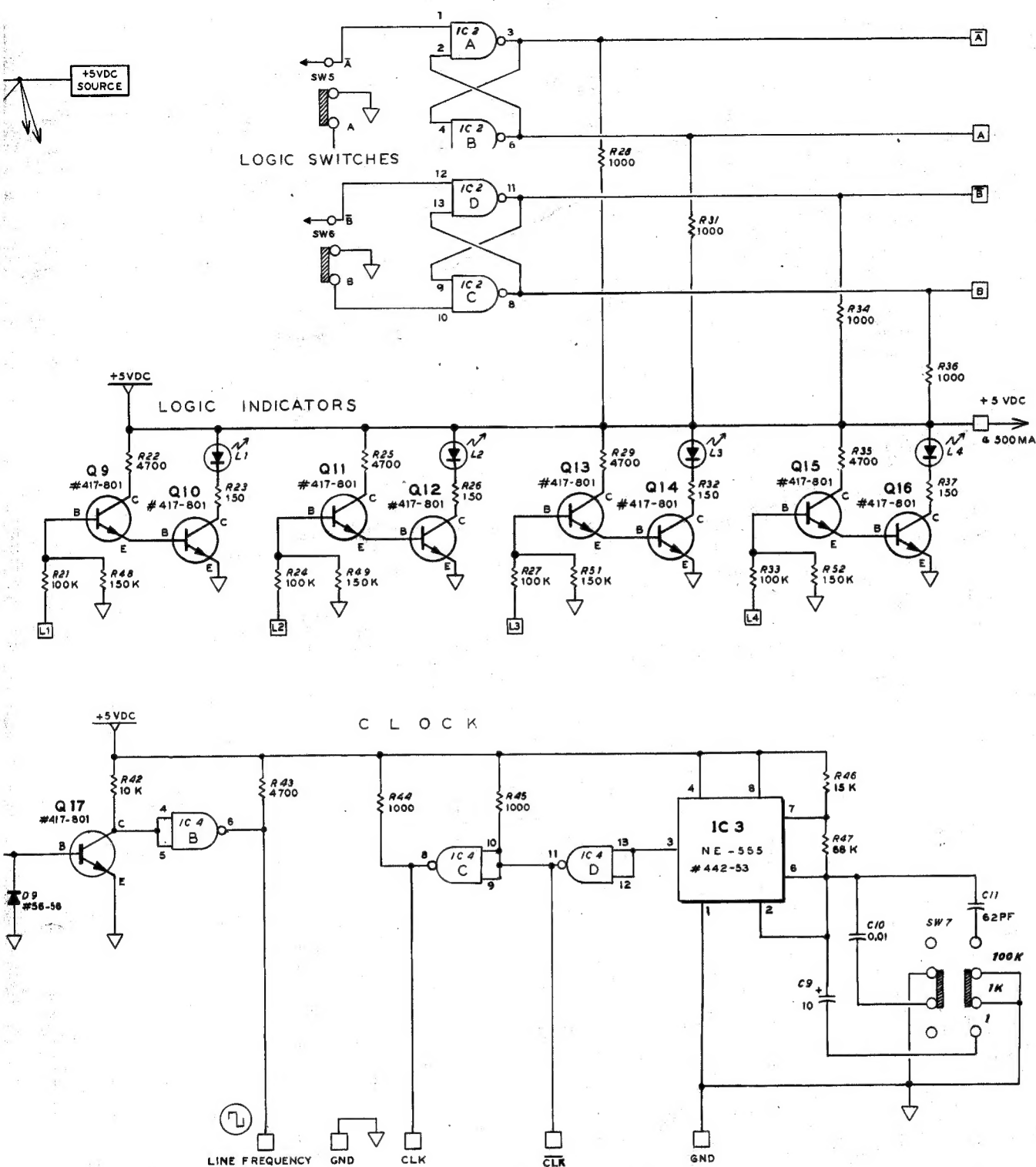


**SCHEMATIC OF THE  
HEATHKIT®  
DIGITAL DESIGN EXPERIMENTER  
MODEL ET-3200B**

1. ALL RESISTOR VALUES ARE IN OHMS: K=1000.
2. ALL RESISTORS ARE 1/4 WATT, 5% UNLESS OTHERWISE INDICATED.
3. ALL CAPACITOR VALUES ARE IN  $\mu$ F UNLESS OTHERWISE INDICATED.
4.  $\nabla$  THIS SYMBOL INDICATES CIRCUIT BOARD GROUND.

**NOTES:**

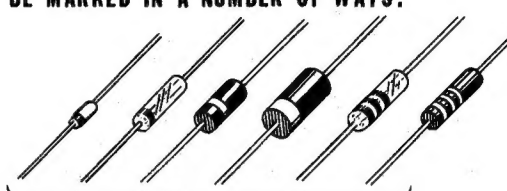
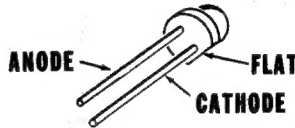
5.  $\equiv$  THIS
6.  $\bigcirc$  THIS WITH POIN
7.  $\bigcirc^*$  THES
8. COMPONENTS I CONTINUED PRI PARTS OF THE PARTS.



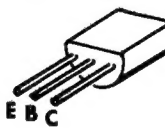
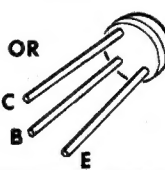
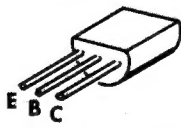
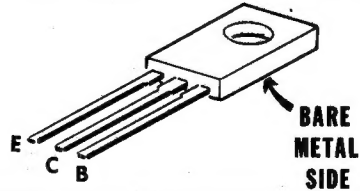
- THIS SYMBOL INDICATES CHASSIS GROUND.
- THIS SYMBOL INDICATES A DC VOLTAGE MEASURED WITH A HIGH IMPEDANCE VOLTMETER FROM THE POINT INDICATED TO CIRCUIT GROUND.
- \* THESE VOLTAGES WILL VARY WITH THE LOAD.
- COMPONENTS IN THE SHADED AREA ARE CRITICAL TO THE CONTINUED PRODUCT SAFETY. REPLACE THEM ONLY WITH PARTS OF THE SAME RATING OR WITH HEATH REPLACEMENT PARTS.

## IDENTIFICATION CHARTS

## DIODES

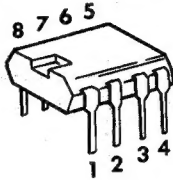
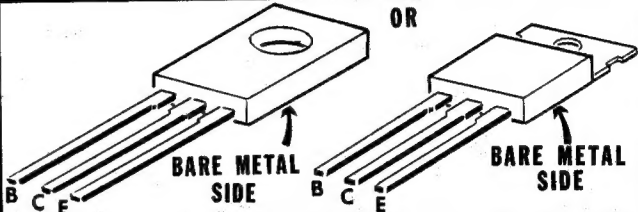
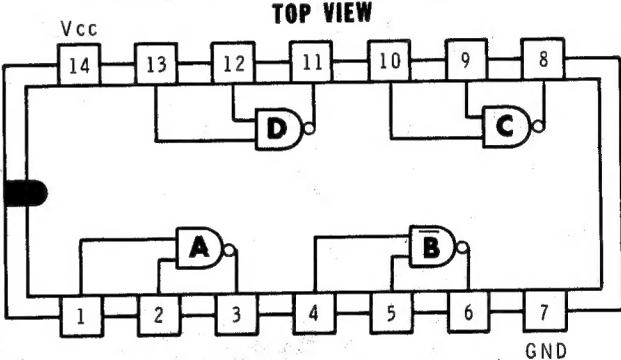
CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
D9	56-56	1N4149	<p>IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS.</p>  <p>BANDED END</p>
ZD1	56-97	1N3017	
D1, D2, D3, D4, D5, D6, D7, D8	57-65	1N4002	
LED1, LED2, LED3, LED4, D11	412-640		

## TRANSISTORS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
Q5, Q7, Q8	417-235	2N4121	 <p>OR</p> 
Q1, Q3, Q4, Q9, Q10, Q11, Q12, Q13, Q14, Q15, Q16, Q17	417-801	MPSA20	
Q2	417-818	MJE181	
Q6	417-819	MJE171	



## INTEGRATED CIRCUITS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MANUFACTURER'S NUMBER	BASE DIAGRAM
IC3	442-53	NE555V	
IC1	442-54	$\mu$ A7805	
IC2, IC4	443-54	SN7403N	

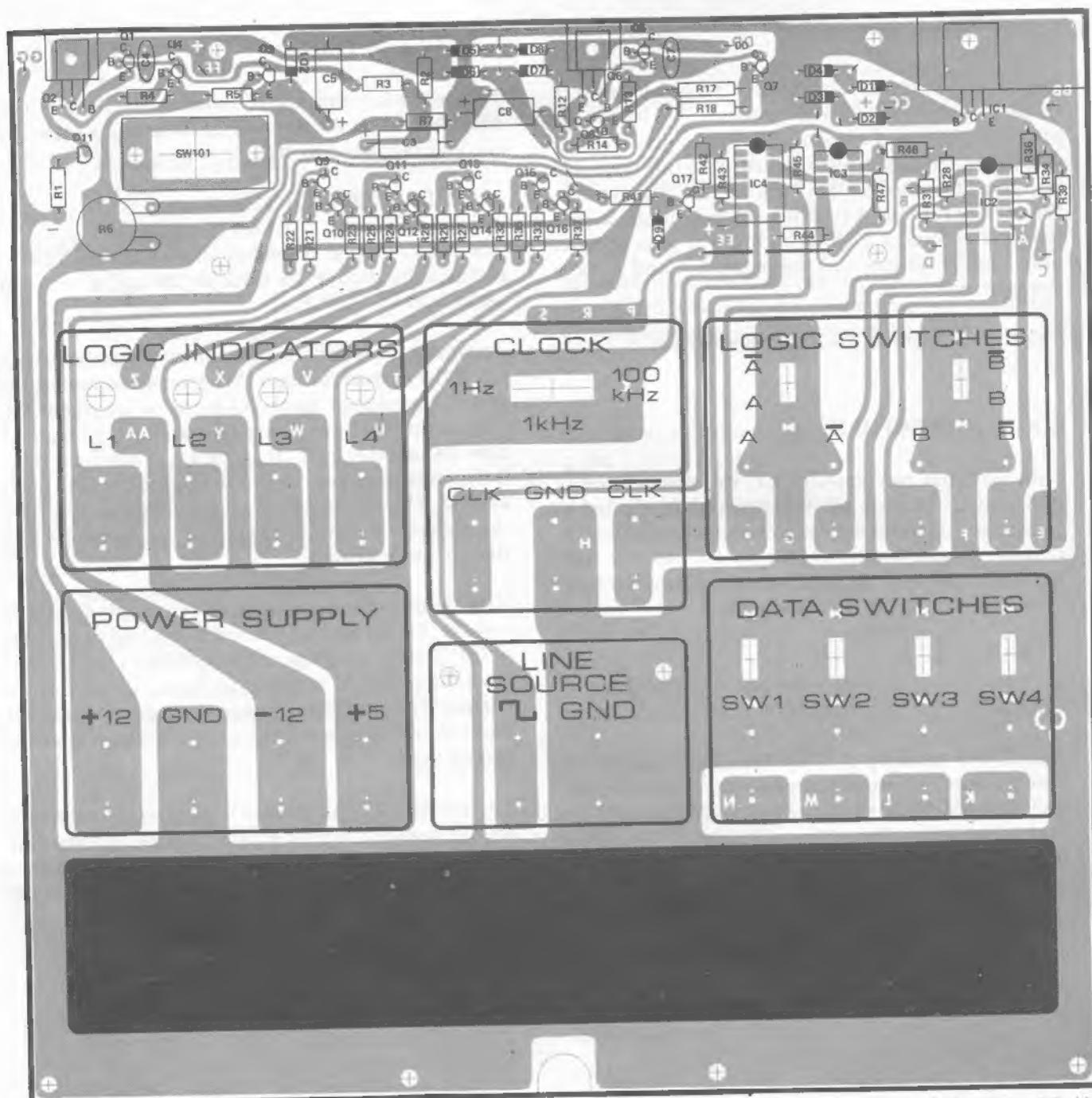
## CIRCUIT BOARD X-RAY VIEW

NOTE: To find the PART NUMBER of a component for the purpose of ordering a replacement part:

A. Find the circuit component number (R5, C3, etc.) on the "X-Ray View."\*

B. Locate this same number in the "Circuit Component Number" column of the "Parts List" in the front of this Manual.

C. Adjacent to the circuit component number, you will find the PART NUMBER and DESCRIPTION which must be supplied when you order a replacement part.



\* Resistors R48, R49, R51, and R52, from the base (B) to gnd on transistors Q9, Q11, Q13, and Q15, respectively, on the foil side of the circuit board, are not shown.